Rivers for Life: Managing Water for People and Nature

I am very pleased to join all of you in launching this week's RiverSymposium activities, and I want to thank the conference organizers for inviting me to come, at some great distance across the international date line, to speak with you today. (new slide) A few weeks ago, I had a talk with my son Henry, who is now 11, about the fact that I was going to Australia to give a talk. He asked if I was going to tell everyone how to save rivers. I chuckled at his question, and tried to dismiss it politely. But ever since, I have been pondering Henry's question. What would I say if someone asked how to protect rivers?

Certainly, the future of our rivers has become more uncertain than ever before. The global human population is expected to grow from 6 to 9 billion in the next 50 years, and the growing demands for water to support cities, food production, and energy generation present daunting challenges for water planners and governments. The likely future ecological impacts associated with any new water development will come on top of considerable ecological damage that has already occurred in the freshwater ecosystems of the world. More than two-thirds of the world's river systems are now moderately to heavily altered by water diversions and fragmented with dams. The polluted condition of many of the planet's waters is depleting or extirpating aquatic species populations, and causing serious health problems around the world. There is no question that the freshwater ecosystems of the world are in considerable peril.

In this context, I do struggle with the question of how to save the world's rivers and their wonderful diversity of life. I do not have definitive answers to offer you today. But after having given the question much thought recently, it seems to me that there are three essential ingredients. It takes desire, it takes ability, and it takes a will to act.

It almost seems moot to try to make the point that the ***desire*** exists to protect rivers, in this vibrant city with a river running through its heart. But protecting rivers takes considerable vigilance, and a great deal of hard work and commitment, so it is important to understand where the motivations for river protection come from, and to ask whether it

is likely to persevere. In trying to better understand where the desire to protect rivers comes from, I wrote to some of my colleagues and asked what had motivated them to become river scientists. I found it interesting that many of them share a common thread of positive memories from their youth. (new slide) For example, my friend Angela Arthington here at Griffith University fondly remembers her early days fishing with her father and siblings in the rivers and bays of New Zealand. (new slide) LeRoy Poff, a stream ecologist at Colorado State University, told me about growing up along the Little Red River in the Ozark Mountains of Arkansas. He wrote, "the aroma of the place is still with me -- the sweating plants and musty aquatic odors co-mingling in the heavy summertime air.: He goes on to say, "The mysteries of the river were intensified when I would visit my grandmother's neighbor, a fisherman who would hang from his clothesline huge and weird-looking fish that he had pulled from the Little Red." (new slide) This is one of the kinds of fish that LeRoy likely found on his neighbor's clothesline – a pallid sturgeon. (new slide) Judy Meyer of the University of Georgia fondly remembered the Menomonee River of her youth, in Wisconsin. She wrote, "My friends and I caught crayfish, moved rocks around to build small pools, or sometimes just waded in the water. Discovery of a leech on my leg was scary, but didn't keep us away. Enlightening encounters with different aspects of human society were also to be found on the Menomonee River. I remember finding someone's stash of Playboy magazines in a crevice under the bridge -- certainly something I had never encountered before! So – says Judy -- my experiences with the river taught me many things about life."

(new slide) My friend Jackie King didn't realize she had such passion for protecting rivers until she learned that the Department of Water Affairs in South Africa had plans to dam the Eerste River, which Jackie had studied for her doctoral dissertation. Jackie tells the story that "In a fit of youthful outrage and naivety I wrote to them asking how much water would be released down 'my' river. They replied very politely asking how much water I thought should continue to go down the river. Jackie says, This threw me into disarray for 15 years, until I figured out how to answer that kind of question!" (new slide) Now thirty years since her graduate school days, Jackie has become one of the world's leading authorities on environmental flow science, and is now advising the

Mekong Commission on the subject. To Jackie, the desire to protect rivers transcends generations and I know that she worries deeply about the future that will be available to these children.

Childhood experiences and memories are strong motivators for protecting rivers later in life. But the desire to protect rivers springs from many places in the human psyche. (new slide) For many human beings, rivers and their floodplains literally give life in the form of food, building materials, or plant-derived medicines. At least a billion humans depend upon fish as their primary source of protein, and many of those fish species spend all or part of their life cycles in rivers. In the U.S., a federal fish and wildlife official has said that "fish habitat is people habitat" because some 44 million anglers fish recreationally, generating more than $40 billion for local economies each year. (new slide) Religion and spirituality are intimately connected to water and rivers, whether you are a Hindu seeking to bathe in the Ganges or a southern African tribal villager that worships the river serpent god Nyaminyami, believed to inhabit the rapids of their cascading rivers. As the singer Roberta Flack once said, "There's a river somewhere that flows through the lives of everyone."

When we damage a river, we mess with people's lives. For this reason, I do not understand what is meant by the need to "balance the needs of humans and nature." This suggests that somehow the needs of humans and nature are different. On which side of the balance scale would you place subsistence fisheries? On which side would you place Nyaminyami? We need better integration, not balance.

I would like to turn now to the central core of my thesis, and address the issue of whether or not we have the ***ability*** to protect rivers. I will focus on two critical elements of this ability – science and engineering.

In both the science and engineering associated with water resource planning and river management, we have seen some remarkable progress in the recent decade. The science to support river management has taken some giant leaps forward. Inquisitive scientists

like Angela Arthington, Jackie King, LeRoy Poff and Judy Meyer (as well as many others in this audience) have contributed enormously in unraveling the mysteries of rivers, and helping us to understand how we need to manage them to sustain their bounty of life. I will share one example of what science has taught us.

(new slide) This is the Colorado pikeminnow, the world's largest minnow, and it is found only in the Colorado River system of the western U.S. It can grow to a meter and a half in length and nearly 40 kilograms in weight. This fish was once a major source of food for Native peoples, and for early European settlers in the region who called it "white salmon." During the winter, in icy cold water and with minimal food available, this animal needs to conserve every bit of its energy reserves. Fortunately, under natural conditions the river flow stays low and its velocity slow, so that this fish can go nearly comatose through the winter and doesn't need to swim against the current and waste energy. Then, in early spring, the snow in the lower mountain areas begins to melt, and the river begins to rise. The fish awakens, knowing that it is time to begin moving into shallowly flooded wetlands where the water is warmer, and insects and small fish are abundant. It begins rebuilding its energy reserves, in readiness to make a long migration to its spawning grounds. By late spring, snow is melting throughout the Colorado River basin, and the river is raging in flood. The floodwaters push enormous volumes of cobbles and gravels downstream, and drops this load in constricted canyons where the floodwaters are slowed. These sediments form perfect spawning beds for the pikeminnow, which is now traveling as much as 500 kilometers to get to one of the few spawning areas in the Colorado River system. As the floodwaters begin to recede in summer, the fine silt and sand is washed out of the gravel, and the pikeminnow lays its eggs in the clean substrate. A week later, the pikeminnow larvae emerge from the gravel, and are carried by the still-high waters into flooded wetland areas, where they can grow quickly in warm, nutrient-rich water.

In this way, pikeminnow are inextricably tied to the natural rhythms of water flow in the Colorado River system. Every bit of the seasonally-varying flow regime – the low flows, the high flow pulses in early spring, the floods that spill onto the floodplain – is essential

to the survival of pikeminnow populations. The natural cycles of low waters and floods sustained pikeminnow populations for at least three million years.

A similar story – or tens or hundreds of such stories – could be told for every river. We now understand that the life of a river and its naturally-varying water flow regime are inseparable. As scientists learn more and more of these stories, they are becoming better able to define the environmental flow requirements needed to support species, healthy, properly functioning ecosystems, and the humans that depend upon them.

(new slide) Recognizing that humans will continue to use water for myriad purposes, river scientists have in recent years begun to address the question of how much alteration in the natural flow regime can be tolerated before the health of a river – including its diversity of life – will become impaired. As a result of studies accumulating around the globe, scientists are now much better able to advise water managers and policy-makers about the environmental consequences of increasingly altering the natural flow regimes of rivers. No longer can policy-makers, governments, or water development interests claim that the science is too uncertain to support these types of decisions. In my travels around the world, I have frequently heard water managers or other water users complain that the scientists cannot give them a number that would tell them how much water the ecosystem needs. It is important to understand that in most river basins, the same could be said for human uses – we simply do not have adequate accounting for human uses in most river basins. While it is true that we do not have quantitative prescriptions for environmental flows for every river on the planet, it is critically important that water managers understand that we do have the scientific methods and the expertise to produce such quantification of the water needs of freshwater ecosystems – and we can do this anywhere. If river protection is given the attention and resources it deserves, the scientists are ready to deliver the necessary answers.

The bigger issue here may not be whether sufficient desire or knowledge exists, but whether or not adequate public participation processes are in place to allow for the full expression of a community's desires and values. To steal from the title of a talk to be

given later this week, “How much water does aboriginal culture need?” The engagement of social scientists and community organizers is an important, and rapidly-evolving aspect of river management. Another keynote speaker, Roy Mussell, will address these issues later this week.

(new slide) How can scientific knowledge and the broad array of social values best be integrated into water management plans? Let me address this conceptually, at first, and then get into a couple of real-world examples. In our book “Rivers for Life”, Sandra Postel and I characterized the prevailing approach to water management using this simple pie diagram. In this case, the pie is a water pie, representing the total water available in a river. We suggested that over time, as humans put more and more of a river’s water to use, the amount of water left to support ecosystem values is gradually diminished. The slice of the pie supporting the river ecosystem eventually gets too small to support ecosystem functions and services. At this point fish populations are crashing, wildlife populations are suffering, water quality is badly degraded, and the river is likely unfit for human subsistence, recreation or tourism.

(new slide) Sandra and I suggested that the world needs to move swiftly into a new mindset for managing water, one in which support of river ecosystems and associated human values is fully integrated into the myriad purposes of river management. In this diagram, human uses of water in cities or farms are embedded within a larger array of values that humans derive from healthy river ecosystems. To manage in a manner consistent with this philosophy, we must recognize that there are limits in the degree to which a river’s flow can be depleted or its natural water flow regime altered. Human uses of water in a given river basin are allowed to expand, but only to the degree that they remain within the limits of sustainability – which is labeled here as the “sustainability boundary.” By identifying the environmental flows necessary to support ecosystem health, river science can help identify where this sustainability boundary lies for any particular river.

Around the world, we are now seeing promising signs that this scientific knowledge can be effectively and pragmatically translated into water engineering plans. I personally believe that this is the brave new frontier of river management. I will share a couple of examples from personal experience. About 10 years ago, the group that I direct for The Nature Conservancy came to the conclusion that the world was in desperate need of some real-world examples to prove that environmentally sustainable water management was feasible. We set out to demonstrate that ecosystem values could be integrated without serious disruption of water plans, existing uses of water, or economies. We sought to prove this point in a variety of water management contexts: municipal water supply planning, hydropower development, flood control. Here are some of our early results.

(new slide) The city of Charlottesville, Virginia – which happens to be my hometown – found itself in the middle of a drought of record a few years ago. I understand that the city of Brisbane is experiencing a fairly severe drought itself, so this story may be particularly pertinent. The Charlottesville water storage reservoirs dropped to dangerously low levels. In response, the water utility put into place some draconian water conservation measures to try to get through the crisis. The finest restaurants in town served their meals on paper plates, just so that the restaurants would not need to run their automatic dishwashers. As the community came out of the drought, the city managers and business community said "never again." They directed the water utility to come up with a 50-year plan that would make the city "drought proof" and support unconstrained growth. (new slide) The Rivanna River – which is the source of this city's water supply -- is very special to this community. Thousands of the city's residents fish in the river, float downstream in canoes, observe the wildlife, and live along its banks. The river harbors a wealth of aquatic diversity, including some endangered species. However, much of this aquatic diversity has already suffered in recent decades, because the city has already been taking too much water out of the river at critical times of the year.

(new slide) The water utility was well under-way with their plans to develop new water infrastructure when we began discussions with them three years ago. We knew that we

were going to need to help them come up with a plan that would meet their long-range water demands, ***and*** improve the environmental flow releases from their storage reservoirs, without costing them any more storage or money than what their engineers were already designing. We accomplished our goal by getting them to adopt a few simple strategies. First, we helped them develop a computerized model to enable them to more efficiently coordinate the use of their three storage reservoirs. Second, we got them to adopt a drought management plan that outlines how, and when, they would implement a sequence of drought responses that begins with voluntary water conservation measures and progresses into mandatory measures with increasing severity of drought. None of these mandatory measures includes shutting off dishwashers in fancy restaurants. Finally, we showed them how to use the historical records of water flows in the catchment, along with a simple probability-based risk management approach, to decide when to activate their drought management plan. As a result, we showed them how they could safely and reliably increase their environmental flow releases more than ten-fold, meet their 50-year water supply needs, with minimal disruption of water use during severe droughts.

All of the water management strategies I've just described are now standard engineering practices in more progressive cities. But too few communities are using this kind of knowledge, and public policies do not mandate their use. There is great opportunity to improve environmental flow conditions simply by improving the way we are managing urban water supplies presently. We are now working with the cities of New York and Denver to do the same things we were able to do in my hometown. Perhaps other cities will begin to listen.

(new slide) Let me take you now to the Savannah River, which forms the border between the states of Georgia and South Carolina. Some big dams were built on this river in the 1960's to provide flood protection for the cities of Augusta and Savannah, Georgia. The dams also provide some hydropower generation, and some municipal water supply. The Army Corps of Engineers has been operating these dams for decades in a manner that satisfied a lot of people, but commercial fishermen and wildlife enthusiasts were not

among them. (new slide) Fish stocks have been declining precipitously. The spectacular baldcypress and tupelo trees in the floodplain forest have not been regenerating. The wildlife has been suffering.

When the Corps launched a new comprehensive planning process a few years ago to better balance the many uses of the river, we jumped at the chance to offer some thoughts about how to improve the environmental flow conditions. (new slide) Over the course of a year, we worked with more than 60 river scientists – most of whom received nothing in compensation because they simply wanted to contribute to better river management – and generated a set of environmental flow recommendations for the Corps to consider. These recommendations included suggested levels for low flows during the dry season, and high flow pulses during the wet. These recommendations differed to some degree during wet years versus dry years. When the Corps' dam engineers examined these recommendations, they realized that they could readily implement most of the recommendations immediately. In fact, they had been releasing more water than would have naturally come downriver during some months, to the detriment of certain native species. And they realized that they could create short-duration "controlled floods" during the spring with only minimal adjustments to the reservoir rule curve that dictates how they manage floodwaters.

A critically important point to make here is the fact that the provision of adequate environmental flows does not necessarily mean reserving water from other human uses. As water is being released from the Corps dams to meet environmental flow needs on the Savannah, it is also generating hydropower, it is meeting required levels of dilution for downstream wastewater discharges, and much of this water would have been released for flood control anyway. Environmental flow requirements can be met in many regulated river basins simply by integrating the environmental flow considerations – what's the right amount of water to be released, and when do we need to release it – so that all water management objectives can be addressed together. It is also important to emphasize the fact that the environmental flow "building blocks" represented here can be implemented in whole, or in part. We feel that it is extremely important to work collaboratively with

water managers to figure out which parts can be implemented now, and which may need to wait until later, given social or economic constraints. By viewing the objective in this progressive manner, we have been able to build trust and confidence with water managers like the Corps, and what we are finding is that once they begin implementing these recommendations in an adaptive management fashion, they become infected with enthusiasm for restoring the river. To illustrate this point, you'll notice that some of our recommendations for the Savannah included some fairly large floods – these floods would inundate parts of the City of Augusta. However, the Corps engineers are already thinking about how they can build a floodway around the edges of town to enable them to increase the levels of flooding they can safely release. When you get military engineers excited about something, they can be a wonder to behold.

(new slide) In March 2004, the Corps of Engineers released its first-ever controlled flood on the Savannah River for the benefit of river ecosystem restoration. This is a picture of General Carl Strock (at the far right), the chief of the Army Corps of Engineers. In front of television cameras and newspaper reporters on that day in March 2004, General Strock said that he hoped that the kind of science and engineering collaboration that had taken place on the Savannah River would soon begin at the other 630 dams managed by his agency.

If I had a week instead of a half-hour, I would share with you similar stories of successful environmental flow restoration from more than 850 rivers in 60 countries around the world. I have chosen today to show you examples from our organizations work, simply because those are stories that I am most familiar with. Many other organizations and agencies are doing miraculous things in this field, and I'm looking forward to hearing many of their stories this week.

(new slide) I will close by returning full circle, to where I started. My personal desire for protecting rivers is very strong, and I know that each of you shares the belief that we need to do more, and we need to do better. Much of my conviction stems from a personal commitment to my son, and to others of his generation and those that will follow. I want

him to always have the chance to frolic in a healthy river on a hot summer day. I want his generation to always have the chance to catch a fish, whether it is to feed their families, or to share the experience of fishing with family and friends, as Angela Arthington did. We all need a river that we can go to for solace, or for renewal, or to feed us.

Yes, we do have a daunting challenge ahead of us. But the ***will*** to protect our planet's rivers must come from all of us in this room. In this conference, each of you has been identified as a "delegate." My dictionary defines a delegate as "a person that is designated to act for, or represent others." I respectfully ask that you take these messages home to your colleagues when you leave this conference. Tell them that there is great passion in the world for protecting rivers. Tell them that the science and engineering knowledge needed to better manage our rivers already exists. And if they try to say to you that we cannot change the way that we have been doing business, simply smile politely at them, reflecting on the spirit that comes from restoration efforts on more than 850 rivers around the world, and tell them, "YES WE CAN!"

Thank you.